DERIVATION AND VALIDATION OF A CLINICAL SCORE TO PREDICT DEATH AMONG NON-PALLIATIVE COVID-19 PATIENTS PRESENTING TO EMERGENCY DEPARTMENTS: THE CCEDRRN COVID MORTALITY SCORE

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ABSTRACT

Background: Predicting mortality from coronavirus disease 2019 (COVID-19) using information available when patients present to the Emergency Department (ED) can inform goals-of-care decisions and assist with ethical allocation of critical care resources.

Methods: We conducted an observational study to develop and validate a clinical score to predict ED and in-hospital mortality among consecutive non-palliative COVID-19 patients. We recruited from 44 hospitals participating in the Canadian COVID-19 ED Rapid Response Network (CCEDRRN) between March 1, 2020 and January 31, 2021. We randomly assigned hospitals to derivation or validation, and pre-specified clinical variables as candidate predictors. We used logistic regression to develop the score in a derivation cohort, and examined its performance in predicting ED and in-hospital mortality in a validation cohort.

Results: Of 8,761 eligible patients, 618 (7·01%) died. The score included age, sex, type of residence, arrival mode, chest pain, severe liver disease, respiratory rate, and level of respiratory support. The area under the curve was 0·92 (95% confidence intervals [CI] 0·91–0·93) in derivation and 0·92 (95%CI 0·89–0·93) in validation. The score had excellent calibration. Above a score of 15, the observed mortality was 81·0% (81/100) with a specificity of 98·8% (95%CI 99·5–99·9%).

Interpretation: The CCEDRRN COVID Mortality Score is a simple score that accurately predicts mortality with variables that are available on patient arrival without the need for diagnostic tests.

Trial registration: Clinicaltrials.gov, NCT04702945

INTRODUCTION

Throughout the coronavirus disease 2019 (COVID-19) pandemic, health systems around the world have been confronted with, and at times overwhelmed by high numbers of critically ill patients.(1,2) For every critically ill patient in the Emergency Department (ED), a number of less severely ill patients present for care, some of whom deteriorate later, placing additional pressure on resources. Accurate, disease-specific mortality prediction is needed to inform shared decision-making with patients and their families around the patients' goals of care, and can allow healthcare systems to allocate resources in the most transparent, objective, and fair manner possible to save as many lives as possible, and facilitate timely access to palliative care, if needed.(3–5)

Numerous models have been developed to predict mortality from COVID-19, but most were at high-risk of bias.(6–8) Many were developed in small or non-representative patient samples, and enrolled patients from the early pandemic before evidence-based treatments had been identified, included palliative patients, censored outcomes, and had moderate predictive performance.(6) The ISARIC 4C Mortality score is the strongest of those developed.(9) However, it included palliative patients, limiting its utility in risk-stratifying non-palliative COVID-19 patients. In addition, the rule was developed using data from the early pandemic. Most other published rules use imaging or laboratory tests, which precludes their use as a first-line triage tool in the ED where decisions on the appropriateness of intubation and mechanical ventilation may have to be made on arrival.(9–14) Our objective was to develop and validate a clinical score that accurately predicts mortality among non-palliative COVID-19 patients, using clinical variables that are readily available on ED arrival.

METHODS

Study design and setting

The Canadian COVID-19 ED Rapid Response Network (CCEDRRN, pronounced "SEDrin") is an ongoing multicentre pan-Canadian registry that enrolls consecutive eligible COVID-19 patients presenting to EDs in hospitals located in eight Canadian provinces, including the four most populous.(15) This study was approved by the research ethics boards of all participating institutions with a waiver of informed consent for enrolment. Model development and reporting followed TRIPOD standards.(16) Funders had no role in

the collection, analysis, or interpretation of the data, the writing of the manuscript, or the decision to submit for publication. All authors vouch for the accuracy and completeness of the data, and for adherence to the protocol. CCEDRRN's patient engagement committee reviewed and provided input into the development of the research question, the choice of outcomes and the study protocol, and reviewed the submitted manuscript. Patient partners were involved in developing CCEDRRN's website and knowledge translation tools to disseminate study results.

Study patients

Participating sites needed to demonstrate ≥99% compliance in enrolling consecutive eligible patients for their data to be included in this study. We included data from 44 of 50 CCEDRRN sites that met this criterion by the time of the data cut (Appendix Table 1).

We included patients with confirmed COVID-19 who presented to the ED of a participating site between March 1, 2020 and January 31, 2021. We defined confirmed COVID-19 as patients presenting with ongoing COVID-19 symptoms and a positive nucleic acid amplification test (NAAT) for severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) obtained within 14 days prior to, or after their arrival in the ED. This allowed us to capture patients who were diagnosed in the community and subsequently presented to the ED, and those with early false negative tests that became positive. We also included patients presenting with COVID-19 symptoms and diagnosed with "confirmed COVID-19" to capture patients who were transferred into a CCEDRRN hospital whose NAAT at the sending site could not be confirmed, and patients who were presumed by treating clinicians to have COVID-19 despite persistently negative NAATs.

We excluded patients under 18 years of age, those whose goals of care precluded invasive mechanical ventilation, and patients transferred to a hospital outside of CCEDRRN, as we would have been unable to ascertain their outcomes (Figure 1). We followed patients for 30 days if they were discharged from the ED, or until hospital discharge if their admission lasted longer than 30 days.

Data collection

Trained research assistants abstracted data from electronic and paper-based medical records into a central, web-based REDCap database (Vanderbilt University; Nashville, TN, USA), and captured demographics, vital signs, symptoms, and comorbidities, COVID-19 exposure risk, diagnostic test results, and patient outcomes. We evaluated the inter-rater agreement of key predictor variables by comparing data collected retrospectively with prospective data.(15) The clinical prediction score was developed after all chart abstractions were complete; research assistants were thus unaware of which clinical variables would be candidate predictor variables.

Outcome

The primary outcome was all-cause ED and in-hospital mortality. All patients had complete follow-up data at the time of the data cut. We categorized patients who were discharged from hospital as alive according to their latest hospitalization.

Statistical analysis

Predictor variables

All candidate predictor variables were recorded in the ED record. We chose candidate predictors based on literature review and clinical knowledge. They included age, sex, pregnancy, type of residence, ED arrival mode, comorbidities, symptoms, arrival heart rate, systolic blood pressure, oxygen saturation, respiratory rate and Glasgow Coma Scale, ED oxygen delivery, lowest oxygen saturation, physician or nurse impression of respiratory distress, and use of alcohol, tobacco, vaping, and illicit substances (Appendix Table 2).

Model development and validation

We randomly assigned participating sites to derivation or validation, with the goal of assigning 75% of eligible patients and outcome events to derivation, and the remaining to validation. We examined candidate predictors for co-linearity, and missing and extreme values in the derivation cohort. A few variables had missing values (systolic blood pressure had the most missing at 4.7%; Appendix Table 2). We used five multiple imputations for predictors if missing categorical data could not reasonably be assumed to be absent (e.g., missing

documentation of illicit substance use was classified as no substance use). The initial logistic regression model considered all candidate predictors, with continuous predictors fit with restricted cubic splines with three knots. We assessed the strengths of associations between predictors and the outcome using an analysis of variance (ANOVA) plot to inform the degrees of freedom to allocate to each predictor. No additional knots were allocated to continuous predictors. We used a fast step-down procedure to reduce the model to key predictors. We conducted an internal bootstrap validation with 1,000 bootstrap samples to provide an optimism-corrected area under the receiver-operating characteristic (AUC). We categorized continuous predictors based on the relationship between the spline function and outcome. To enable easy clinical use, we categorized age into decades, and arrival respiratory rate cut points of 20 and 30, and assigned integer points to be added to calculate the score. We used a nomogram to assign points to form a score that ranged from -1 to 17. We calculated the sensitivity and specificity at different point thresholds, along with the score's discrimination and calibration. We validated the model in a cohort of geographically distinct sites that were not part of derivation, and used a single imputation for the few missing respiratory rates (4% were missing). We assessed outcomes independently for ED visits, irrespective of potential subsequent visits leading to death.

Validation of previously published models

We used our study cohort to externally validate other risk prediction tools: the SEIMC score,[12] the 4C Mortality Score,[10] and the VACO Index.[20] We chose these three because they performed well in validation, and the majority of their predictors were available in our data. We calculated the AUCs for these risk prediction tools using cases with complete data on as many predictors as possible.(17)

We performed analyses in R using the rms package and used the pmsampsize package for sample size determination.(18) To ensure patient privacy, a cell size restriction policy prohibited reporting counts of less than five.

Sample size

Assuming an event rate of less than 10%, shrinkage of 0.9, and a conservative Cox-Snell R-squared of 0.1, 8.5 events per degree of freedom were required for reliable prediction modeling in the derivation cohort.(19) The 42 candidate predictor variables had 49 degrees of freedom indicating 417 events were required. In the derivation cohort, there were 6,758 patients who made 7,420 ED visits. The derivation cohort exceeded the number of events required.

RESULTS

We assessed 9,704 consecutive COVID-19 patients who made 10,670 ED visits between March 1, 2020 and January 31, 2021 (Figure 1). We excluded 943 patients who met one or more exclusion criteria, and included 8,761 patients who made 9,605 visits in our analyses. The follow-up time was 30 days for discharged patients and between 30 and 229 days for admitted patients. Of these, 618 (7.0%) died in ED or hospital and met the primary outcome. In the derivation cohort, 6,758 patients made 7,420 ED visits to 32 sites (Appendix Table 1). In the validation cohort, 2,054 patients made 2,185 ED visits to 14 different sites. In the derivation cohort 2,705 (36.5%) patients presented during the early pandemic, between March 1 and June 30, 2020, and 4,711 (63.7%) between July 1, 2020 and January 31, 2021 (Table 1). In the validation cohort, 6158 (28.4%) presented during the early pandemic, and 1,567 (71.7%) after July 1, 2020.

In derivation, the step-down procedure produced a final model with eight variables (Table 2). The derived model had an optimism-corrected AUC of 0.92. The resulting risk score ranged from -1 to 17. The derivation cohort was well distributed across the CCEDRRN COVID Mortality Score range, and had excellent calibration (calibration intercept of 0 and slope of 1) and discrimination with an AUC of 0.92 (95% CI 0.90 to 0.92, Appendix Figure 1).

The CCEDRRN COVID Mortality Score had similar performance in validation. The validation cohort was also distributed across the score ranges, had excellent calibration (calibration intercept of 0 and slope of 1) and discrimination (AUC of 0.92 [95% CI 0.89 to 0.93], Figure 2).

The score had excellent performance across a range of thresholds to rule in and rule out in-hospital mortality (Appendix Tables 4 and 5). These results suggest that scores less than or equal to six would categorize patients at low risk of in-hospital mortality, with a negative predicted value of 99.9%. Patients in the low-risk group had an in-hospital mortality of 0.1%. For scores greater than or equal to 15, the observed in-hospital mortality was 81.0% and the CCEDRRN COVID Mortality Score would categorize patients at high risk of in-hospital mortality, with a specificity of 99.8% and positive predictive value of 81.0%.

We conducted an external validation of three risk scores (Figure 3, Appendix Table 5). These scores performed well for the patients with data available yielding AUCs of nearly 0.88, below the AUC of the CCEDRRN COVID Mortality Score (unadjusted for multiple testing and using the validation cohort: AUC for the CCEDRRN COVID Mortality Score was higher compared to the SEIMC score [p=0.035] and the VACO Index [p=0.002], with no evidence of a difference for the 4C Mortality Score [p=0.072]).

INTERPRETATION

Main results

We derived and validated a parsimonious and simple score to predict in-hospital mortality among non-palliative patients presenting to EDs with COVID-19: the CCEDRRN COVID Mortality Score. We found that eight readily available clinical variables that can be ascertained at the bedside shortly after ED arrival to accurately predict mortality. The CCEDRRN COVID Mortality Score had excellent calibration and discrimination in a geographically distinct cohort of patients who presented to other sites. The CCEDRRN COVID Mortality Score can be used as a highly sensitive score to rule out in-hospital mortality in low-risk patients with a score up to and including six. It can also be used as a rule-in score with scores of 15 or higher being highly specific for in-hospital mortality.

Critically ill COVID-19 patients typically require aggressive medical management in the ED shortly after their arrival. Being able to accurately and reliably predict mortality risk on arrival before endotracheal intubation occurs can offer the opportunity to inform discussions about patients' goals of care, and facilitate early high-

quality end of life care for patients most likely to die despite maximum medical intervention. Accurate mortality prediction may be essential when surging cases threaten to overwhelm critical care resources. In those rare situations, the CCEDRRN COVID Mortality Score can guide allocation of scarce resources.

Explanation of the findings

Our model has strengths compared to prior models.(6) We developed the CCEDRRN COVID Mortality Score using simple and readily available variables at the bedside. As a result, our model could be externally validated for use in remote areas without access to laboratory testing or imaging, and in low-income countries where access may be limited or costly. In contrast to prior models, we excluded patients with palliative goals of care, for whom invasive mechanical ventilation was not offered to ensure our model did not predict patients who were expected to succumb, or ineligible for the highest level of critical care.(9–11,13,14,20–24) This avoids the potential for self-fulfilling prophecy bias, whereby the prognostic model predicts the outcome that occurred as a result of a decision to withhold life-sustaining measures.(25–27) Prior models were derived or validated during the early pandemic while COVID-19 testing was restricted to those with severe disease, and did not include consecutive eligible patients, both of which may have resulted in selection bias. Mortality in prior studies ranged from 13% to 30%,(9,11,12,14,22–24) in contrast to 7% in our study.

Our rule's predictive ability depends mostly on age, the patient's respiratory status. The only comorbidity retained in the final model was moderate to severe liver disease. Two other rules also identified liver disease as a mortality risk factor, perhaps due to the potential for virus-induced liver inflammation.(14,20,28) Other prognostic decision rules have used similar analytic approaches,(20,22,23) but had lower predictive performance with c-statistics ranging from 0.80 to 0.82, and were based on patients from the early pandemic. Other rules have incorporated measures of hypoxemia or respiratory support, corroborating their strong predictive power.(9–13,20–24) Goodacre et al. identified performance status as a risk factor for increased mortality. In our dataset, this was most closely reflected by arrival from long-term care, which reflected patients with lower performance status.(23)

Limitations of the study

Canada represents a culturally diverse country that offers its citizens universal health coverage. Our model needs to be externally validated in other health systems. Our model predicts in-hospital mortality, and may have missed out-of-hospital deaths that occurred after discharge; however, these are believed to be rare. Our model was based on patients with confirmed COVID-19. While many patients presented to the ED with NAAT confirmed COVID-19, validation in a cohort of patients with suspected COVID-19 is needed.

Future directions in the area of study

As vaccination campaigns roll out around the world, the performance of risk tools will need to be evaluated in patients who are vaccinated and may have a different risk of dying from COVID-19.

Conclusion

In summary, the CCEDRRN COVID Mortality Score is a simple clinical risk score that can be applied in the ED at the bedside to predict a patient's mortality risk. This tool can be used to inform goals of care decisions.

Authors' contributions

CMH, RJR, JJP, LJM, PA and SCB conceived the study, with input on the design and selection of variables from all other contributors. CMH, LJM, PA, and SCB obtained funding on behalf of the CCEDRRN investigators. CMH, PA, SCB, EM, MW, JH, TJ, VH, and GC managed data collection along with other members of the CCEDRRN, and verify the accuracy of underlying data. CMH, RJR, FOS and JJP developed the analytic plan. FOS performed the analysis, with assistance from RJR, CMH and JJP, including accessing and verification of underlying data. All contributors provided input on the interpretation our findings. CMH and PA drafted the manuscript. All authors reviewed and provided critical input to the final manuscript.

Data sharing

The CCEDRRN network endorses the guidance put forth by the World Health Organization to enable data sharing to optimize learning. CCEDRRN accepts applications for access to data by external investigators, prioritizing data requests by network Members.

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Thank you to all of our patient partners who shared their lived experiences and perspectives to ensure that the knowledge we co-create addresses the concerns of patients and the public. Creating the largest network of collaboration across Canadian Emergency Departments would not have been feasible without the tireless efforts of Emergency Department Chiefs, and research coordinators and research assistants at participating sites. Finally, our most humble and sincere gratitude to all of our colleagues in medicine, nursing, and the allied health professions who have been on the front lines of this pandemic from day one staffing our ambulances, Emergency

Departments, ICUs and hospitals bravely facing the risks of COVID-19 to look after our fellow citizens and after one another. We dedicate this network to you.

TABLES & FIGURES

Figure 1. Flow diagram of included and excluded Emergency Department visits

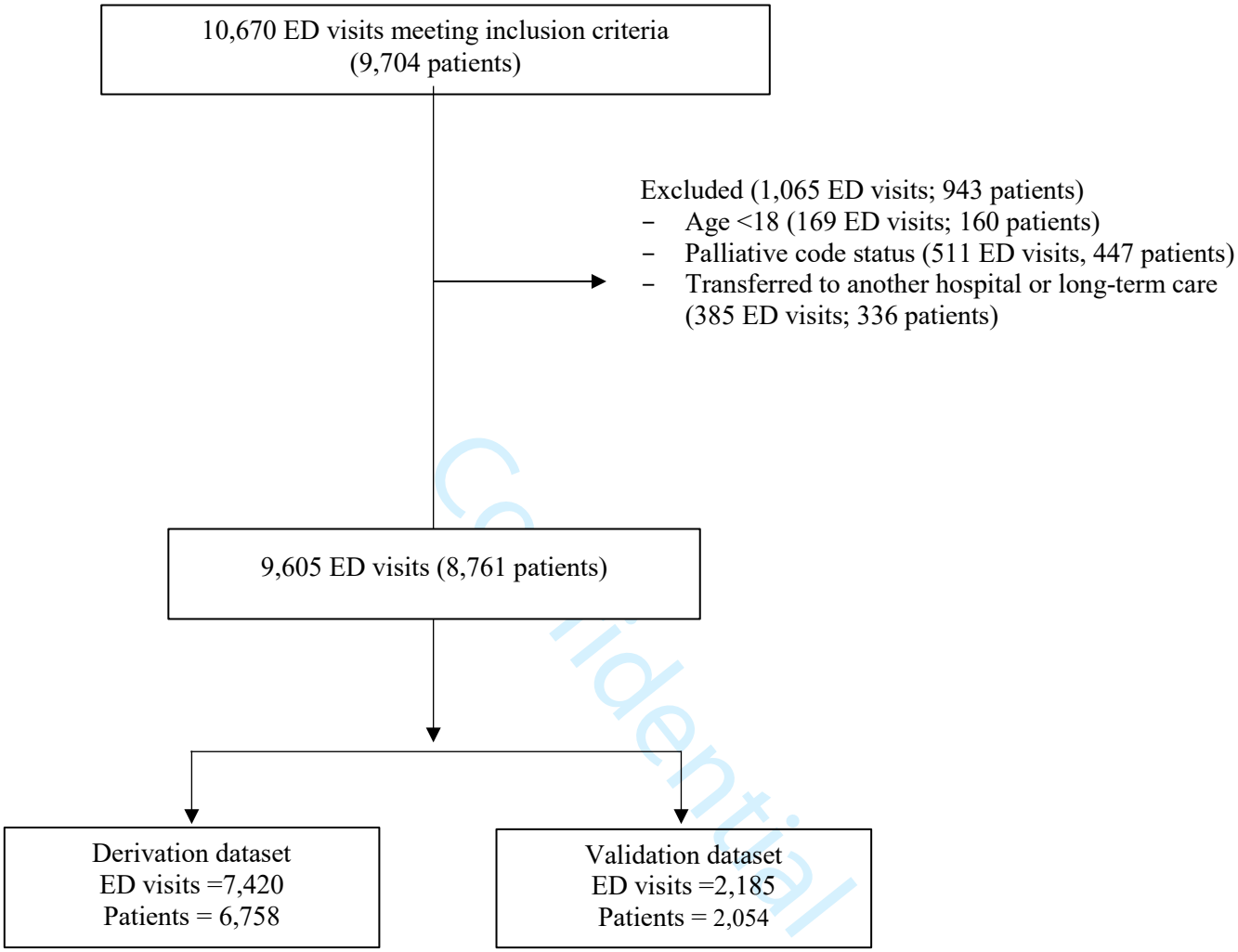


Table 1. Characteristics and outcomes of patients in the derivation and validation cohorts

		Derivation Cohort (n=7,420)	Validation Cohort (n = 2,185)
Age in years, Mean (SD)		54·7 (19·8)	53·6 (19·9)
Female (%)		3544 (47·8)	1149 (52·6)
Province (%)			
	Quebec	2992 (40·3)	369 (16·9)
	British Columbia	1839 (24·8)	291 (13·3)
	Alberta	1718 (23·2)	775 (35·5)
	Ontario	732 (9·9)	379 (17·4)
	Saskatchewan	75 (1·0)	329 (15·1)
	Nova Scotia	64 (0·7)	33 (1·51)
	New Brunswick	<5	9 (0·41)
Arrival from (%)			
	Home	6639 (89·5)	2005 (91·8)
	Institution	631 (8·5)	120 (5·5)
	No fixed address	108 (1·5)	60 (2·8)
Arrival mode (%)			
	Self	4432 (59·7)	1236 (56·6)
	Ambulance or police	2987 (40·3)	948 (43·4)
Infection risk (%)			
	Household or caregiver contact	1064 (14·3)	253 (11·6)
	Institutional exposure (e.g., LTC, prison)	828 (11·2)	152 (7·0)
	Healthcare worker	385 (5·2)	107 (4·9)
	Travel from country with known cases within 14 days	296 (4·0)	78 (3·6)
Arrival heart rate, beats /min, mean (SD)		93·4 (18·6)	92·6 (18·1)
Arrival systolic blood pressure, mmHg, mean (SD)		131·0 (21·1)	130·9 (20·4)
Arrival diastolic blood pressure, mmHg, mean (SD)		78·2 (13·0)	78·9 (13·0)
Arrival respiratory rate/min, mean (SD)		21·0 (6·2)	20·6 (5·5)
Arrival temperature in degrees Celcius, mean (SD)		37·2 (0·9)	37·0 (0·9)
Presence of respiratory distress (%)		1567 (21·1)	446 (20·4)
Top 10 COVID symptoms (%)			
	Cough	3938 (53·1)	1247 (57·1)
	Shortness of breath (dyspnea)	3616 (48·7)	1096 (50·2)
	Fever	3216 (43·3)	832 (38·1)
	Fatigue/malaise	1992 (26·9)	697 (31·9)
	Chest pain (includes discomfort or tightness)	1606 (21·6)	497 (22·8)
	Headache	1263 (17·0)	415 (19·0)

	Nausea/vomiting	1201 (16·2)	468 (21·4)
	Chills	1194 (16·1)	339 (15·5)
	Muscle aches (myalgia)	1136 (15·3)	384 (17·6)
	Diarrhea	1016 (13·7)	373 (17·1)
Top 10 comorbidities (%)			
	Hypertension	2179 (29·4)	625 (28·6)
	Diabetes	1247 (16·8)	319 (14·6)
	Dyslipidemia	1161 (15·7)	252 (11·5)
	Mental health diagnosis	670 (9·0)	270 (12·4)
	Hypothyroidism	547 (7·4)	141 (6·5)
	Asthma	535 (7·2)	186 (8·5)
	Coronary artery disease	487 (6·6)	114 (5·2)
	Chronic neurologic disorder (not dementia)	423 (5·7)	101 (4·6)
	Chronic lung disease (not asthma or pulmonary fibrosis)	379 (5·11)	132 (6·0)
	Dementia	362 (4·9)	86 (3·9)
Smoking or vaping (%)			
	Current	573 (7·7)	190 (8·7)
	Past or never	6847 (92·3)	1995 (91·3)
Illicit substance use (%)			
	Current	130 (1·8)	83 (3·8)
	Past or never	7290 (98·3)	2102 (96·2)
Oxygen required in the Emergency Department (%)		1341 (18·1)	302 (13·8)
Emergency Department disposition (%)			
	Discharged	4488 (60·5)	1320 (60·4)
	Admitted	2858 (38·5)	848 (38·8)
	Left against medical advice	18 (0·2)	6 (0·3)
	Died in Emergency Department	22 (0·3)	6 (0·2)
Died in Emergency Department or in hospital (%)		471 (6·4)	147 (6·7)

LTC=long term care

Table 2. Adjusted associations between predictor variables and mortality, and points for the CCEDRRN COVID Mortality Score

Variable	Categories	Estimate	Standard Error	Odds Ratio	95% CI	Points
Age (yrs.)*		2·85	0·41	17·30	(7·75, 38·6)	
	<40					0
	40-49					4
	50-59					5
	60-69					6
	70-79					7
	≥80					8
Sex						
	Male	Ref	Ref	Ref	Ref	1
	Female	-0·61	0·12	0·54	(0·43, 0·69)	0
Arrival From						
	Home (Community)	Ref	Ref	Ref	Ref	0
	No fixed address	0·17	0·63	1·19	(0·35, 4·09)	0
	Institutional	0·59	0·14	1·80	(1·38, 2·35)	1
Arrival Mode						
	Self	Ref	Ref	Ref	Ref	0
	Ambulance/Police	0·63	0·15	1·89	(1·41, 2·52)	1
Chest Pain		-0·80	0·24	0·45	(0·28, 0·72)	-1
Moderate/Severe Liver disease		1·94	0·50	6·95	(2·61, 18·5)	2
Arrival Respiratory Rate ǂ		0·29	0·10	1·34	(1·09, 1·63)	
	<20					0
	20-29					2
	30+					3
Mode and Level of Oxygen in ED						
	No oxygen	Ref	Ref	Ref	Ref	0
	Nasal prongs <6L/m	0·70	0·14	2·00	(1·53, 2·62)	1
	Facemask, simple rebreather, or ≥6L/min via nasal prongs	1·94	0·19	6·98	(4·79, 10·16)	2
	BiPAP/CPAP/HFNO	2·56	0·27	12·98	(7·62, 22·08)	3
	ED Intubation	2·53	0·29	12·5	(7·11, 21·98)	3

Odds ratio for age was calculated for the upper quartile (≥70 years) versus the lower quartile (≤39 years). The Odds ratio for arrival respiratory rate was calculated for the upper quartile (>22) versus the lower quartile (<18). BiPAP=bilevel positive airway pressure. CPAP=continuous positive airway pressure. HFNO=high-flow nasal oxygen.

Figure 2. Distribution and performance of the CCEDRRN COVID Mortality Score in the validation cohort (left panel) and combined derivation and validation cohorts (right panel): A) distribution of the score, B) observed in-hospital mortality across the range of the score, C) predicted versus observed probability of in-hospital mortality, and D) receiver operating characteristic curve with area under the curve (AUC) and associated 95% confidence interval.

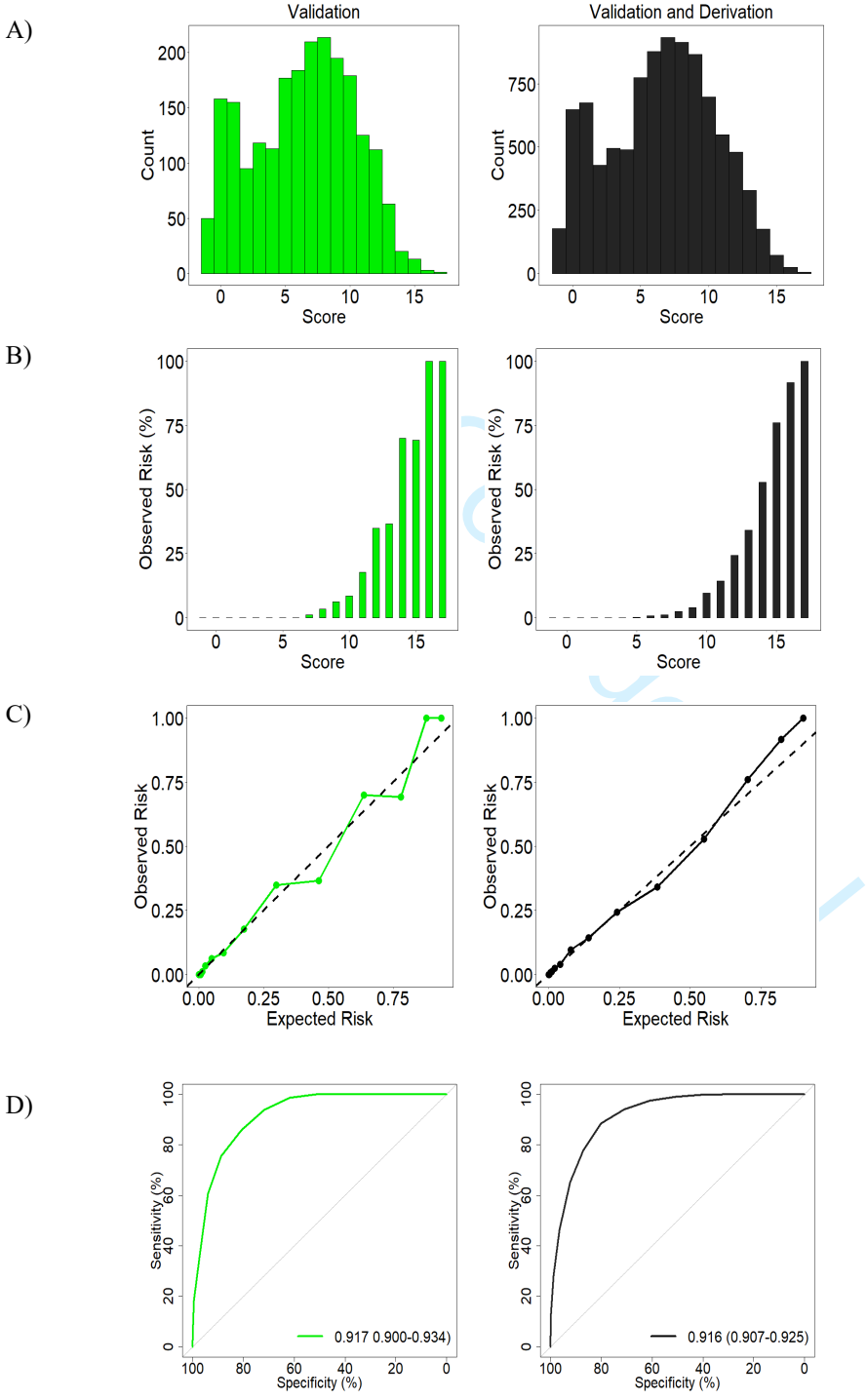
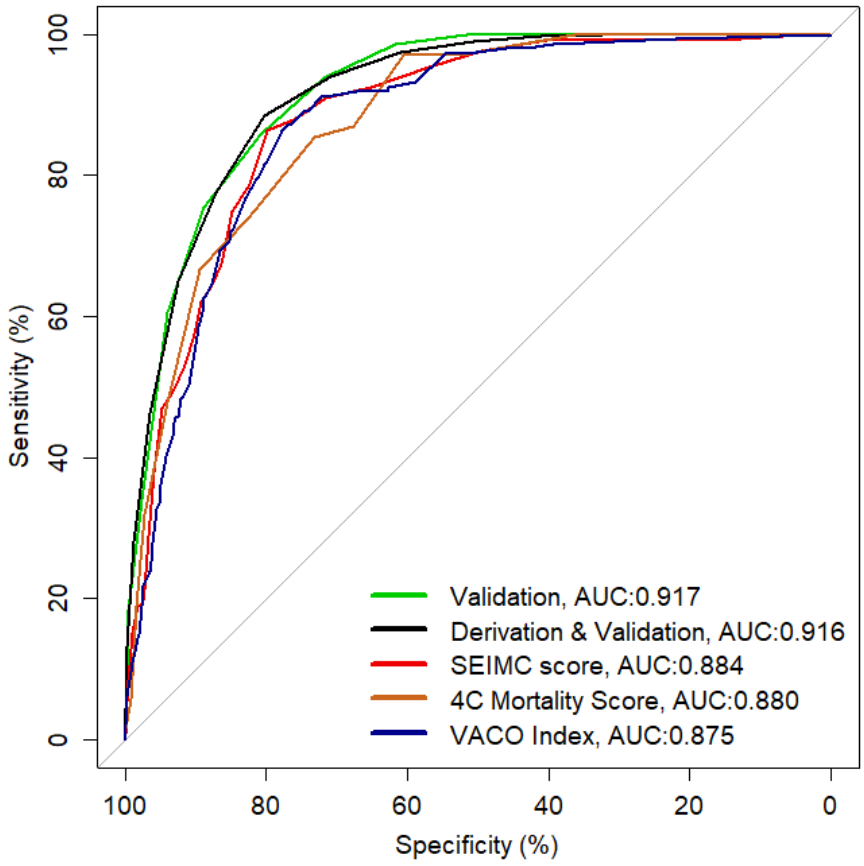


Figure 3. Receiver operator curves and area under the curve (AUC) for the CCEDRRN COVID Mortality Score in the derivation and validation cohorts, the SEIMC score (Berenguer et al.),(11) **the 4C Mortality Score (Knight et al.),**(9) **and the VACO Index (King et al.) in the validation cohort.**(20)



APPENDICES

Appendix Table 1. Characteristics and enrolment periods for participating sites

Hospital	Province	Start Date	End Date	Hospital Type		Derivation cohort	Validation cohort
				Rural/ Urban	Teaching	n	n
Vancouver General Hospital	BC	Mar 1, 2020	Jun 30, 2020	Urban	Teaching	91	
Lions Gate Hospital	BC	Mar 1, 2020	Sep 19, 2020	Urban	NT		142
Saint Paul's Hospital	BC	Mar 1, 2020	Mar 20, 2020	Urban	Teaching		59
Mount St Joseph's Hospital	BC	Mar 1, 2020	Oct 31, 2020	Urban	NT		90
Surrey Memorial Hospital	BC	Mar 19, 2020	Sep 20, 2020	Urban	Teaching	895	
Royal Columbian Hospital	BC	Mar 1, 2020	Nov 15, 2020	Urban	Teaching	221	
Abbotsford Regional Hospital	BC	Apr 20, 2020	Jul 15, 2020	Urban	NT	329	
Eagle Ridge Hospital	BC	Mar 1, 2020	Nov 30, 2020	Urban	NT	162	
Royal Inland Hospital	BC	Mar 1, 2020	Nov 30, 2020	Urban	NT	35	
Kelowna General Hospital	BC	Mar 1, 2020	Nov 2, 2020	Urban	Teaching	105	
University of Alberta Hospital	AB	Apr 8, 2020	Oct 5, 2020	Urban	Teaching	263	
Foothills Medical Centre	AB	Mar 1, 2020	Oct 14, 2020	Urban	Teaching	511	
Rockyview General Hospital	AB	Mar 1, 2020	Oct 24, 2020	Urban	Teaching		446
Peter Lougheed Centre	AB	Mar 1, 2020	Oct 17, 2020	Urban	Teaching	829	
South Health Campus	AB	Mar 1, 2020	Oct 17, 2020	Urban	Teaching		329
Royal Alexandra Hospital	AB	Mar 1, 2020	May 7, 2020	Urban	Teaching		180
Northeast Community Health Centre	AB	Mar 1, 2020	Nov 06, 2020	Urban	Teaching	115	
St Paul's Hospital	SK	Mar 17, 2020	Dec 5, 2020	Urban	Teaching		149
Royal University Hospital	SK	Mar 17, 2020	Sep 20, 2020	Urban	Teaching	33	
Saskatoon City Hospital	SK	Mar 17, 2020	Nov 17, 2020	Urban	Teaching	42	
Sunnybrook Hospital	ON	May 14, 2020	Jul 31, 2020	Urban	Teaching		86
The Ottawa Hospital - Civic	ON	Mar 1, 2020	Nov 30, 2020	Urban	Teaching	214	
The Ottawa Hospital - General	ON	Mar 1, 2020	Oct 31, 2020	Urban	Teaching		293
Kingston General Hospital	ON	Mar 1, 2020	Dec 31, 2020	Urban	Teaching	32	
Hamilton General Hospital	ON	Mar 1, 2020	Aug 31, 2020	Urban	Teaching	46	
Jurvinski Hospital	ON	Mar 1, 2020	Aug 31, 2020	Urban	Teaching	42	
Health Science North	ON	May 14, 2020	Jul 25, 2020	Urban	NT	10	
University Hospital - LHSC	ON	Mar 1, 2020	Nov 30, 2020	Urban	Teaching	312	
Toronto Western Hospital	ON	Sep 1, 2020	Sep 19, 2020	Urban	Teaching	76	
HôtelHôtel-Dieu de Lévis	QC	Mar 1, 2020	Nov 17, 2020	Urban	NT	267	
Jewish General Hospital	QC	Mar 1, 2020	May 3, 2020	Urban	Teaching	815	
CHUL	QC	Mar 1, 2020	Nov 15, 2020	Urban	Teaching		57

Royal Victoria Hospital	QC	Mar 1, 2020	Oct 31, 2020	Urban	Teaching	789	
Hôpital de l'Enfant-Jésus	QC	Mar 1, 2020	May 4, 2020	Urban	Teaching	51	
Hôpital du Saint-Sacrement	QC	Mar 1, 2020	Nov 15, 2020	Urban	Teaching	33	
Hôpital Saint-François d'Assise	QC	Mar 1, 2020	Nov 15, 2020	Urban	Teaching	56	
Hôtel-Dieu de Québec	QC	Mar 1, 2020	Nov 15, 2020	Urban	Teaching	21	
IUCPQ	QC	Mar 1, 2020	Nov 15, 2020	Urban	Teaching		312
Hôpital du Sacré-Coeur	QC	Mar 17, 2020	Jun 11, 2020	Urban	Teaching	664	
Montreale General Hospital	QC	Mar 1, 2020	Nov 30, 2020	Urban	Teaching	296	
Saint John Regional Hospital	NB	Mar 1, 2020	Nov 30, 2020	Urban	Teaching		9
Halifax Infirmary	NS	Mar 1, 2020	Nov 24, 2020	Urban	Teaching	37	
Dartmouth General Hospital	NS	Mar 1, 2020	Nov 24, 2020	Com	NT	16	
Hants Community Hospital	NS	Mar 1, 2020	Nov 24, 2020	Rural	NT		<5
Cobequid Community Health Centre	NS	Mar 1, 2020	Nov 24, 2020	Com	NT	11	
Secondary Assessment Centers	NS	Mar 26, 2020	May 15, 2020	Urban	Teaching		31

BC=British Columbia, AB=Alberta, SK=Saskatchewan, ON=Ontario, QC= Québec, NB:=New Brunswick, NS= Nova Scotia, LHSC=London Health Sciences Centre, CHUL=Centre Hospitalier de l'Université Laval, IUCPQ=Institut universitaire de cardiologie et de pneumologie de Québec, Com=community

Appendix Table 2. Candidate variables for entry into regression model

Variable	Definition	N (%) Missing
Demographics		
Age	Age in years	0 (0)
Sex	Male, Female, Other	0 (0)
Arrival from		0 (0)
	Home + Inter-hospital transfer + other (not clearly documented)	42 (0.6)
	Single room + no fixed address + shelter	
	Institutional living: long-term care/rehab + correctional	
Emergency department variables		
ED arrival mode		0 (0)
Ambulance:	arrived by ambulance	
Self/police	self-transported or transported to ED by police	
Arrival heart rate	beats/minute	131 (1.8)
Arrival respiratory rate	breaths/minute	324 (4.4)
Arrival oxygen saturation	%	131 (1.8)
Arrival systolic blood pressure	mmHg	352 (4.7)
Fever	Temperature ≥37.5 OR self-reported fever	0 (0)
Respiratory distress	Increased work of breathing documented by treating clinician and Patient-reported symptom of shortness of breath as documented by treating clinician	0 (0)
Bloodwork in ED	Yes/No	
Supplemental oxygen delivered in the ED	Yes/No	0 (0)
COVID symptoms		
Chest pain (includes discomfort or tightness)	Patient-reported symptom as documented by treating clinician	0 (0)
Chills	Patient-reported symptom as documented by treating clinician	0 (0)
Cough	Patient-reported symptom as documented by treating clinician	0 (0)
Dysgeusia/anosmia	Patient-reported symptom as documented by treating clinician	0 (0)
Fatigue/malaise	Patient-reported symptom as documented by treating clinician	0 (0)
Headache	Patient-reported symptom as documented by treating clinician	0 (0)
Hemoptysis (bloody sputum)	Patient-reported symptom as documented by treating clinician	0 (0)
Muscle aches (myalgia)	Patient-reported symptom as documented by treating clinician	0 (0)
No reported symptoms	Patient-reported symptom as documented by treating clinician	0 (0)
Current tobacco user	Documented current tobacco use	0 (0)
Current illicit user	Documented methamphetamine, opioid or other illicit drug use	0 (0)
Pregnant	Documented current pregnancy	0 (0)
Arrival confusion	Patient-reported symptom of altered consciousness/confusion or Glasgow Coma Score of <14	0 (0)
Covid Symptom-gastric	Patient-reported symptom of diarrhea and nausea/vomiting	0 (0)
Mode of oxygen delivery combined with oxygen received in the ED	Documented mode of oxygen delivery, combined with maximum oxygen received if given nasal prongs. Most invasive method of oxygen delivery selected if more than one documented.	0 (0)
	Intubation	
	BiPap + CPAP + HFNO	
	Facemask + simple rebreather + non-rebreather + nasal prongs with > 6L/min	
	Nasal prongs <5L/min	
	No oxygen	
Common Comorbid Conditions, n (%)		
Active malignant neoplasm (cancer)	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis.	0 (0)
Coronary artery disease	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis.	0 (0)
Congestive heart failure	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis.	0 (0)
Hypertension	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis.	0 (0)
Asthma	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis.	0 (0)

Chronic kidney disease	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis.	0 (0)
Dialysis	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Diabetes	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Moderate/severe liver disease	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Organ transplant	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Dementia	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Rheumatologic disorder	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Obesity (clinical impression)	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)
Atrial fibrillation	The diagnosis, conditions, problem or circumstances for the patient's ED visit that is in addition to the main diagnosis	0 (0)

Appendix Table 3. Performance of the CCEDRRN COVID Mortality Score to rule out and rule in in-hospital mortality at different cut-off values in the validation cohort.

Score	n (%)	Sensitivity (%, 95% CI)	Specificity (%, 95% CI)	Negative LR	Positive LR	PPV (%)	NPV (%)	Mortality (%)
Rule out:								
≤-1	50 (2·3)	100 (97·5-100)	2·5 (1·8-3·2)	0·0	1·0	6·9	100	0·0
≤0	208 (9·5)	100 (97·5-100)	10·2 (8·9-11·6)	0·0	1·1	7·4	100	0·0
≤1	363 (16·6)	100 (97·5-100)	17·8 (16·2-19·5)	0·0	1·2	8·1	100	0·0
≤2	458 (21·0)	100 (97·5-100)	22·5 (20·7-24·3)	0·0	1·3	8·5	100	0·0
≤3	576 (26·4)	100 (97·5-100)	28·3 (26·3-30·3)	0·0	1·4	9·1	100	0·0
≤4	689 (31·5)	100 (97·5-100)	33·8 (31·8-35·9)	0·0	1·5	9·8	100	0·0
≤5	866 (39·6)	100 (97·5-100)	42·5 (40·3-44·7)	0·0	1·7	11·1	100	0·0
≤6	1050 (48·1)	100 (97·5-100)	51·5 (49·3-53·7)	0·0	2·1	13·0	100	0·0
≤7	1260 (57·7)	98·6 (95·2-99·8)	61·7 (59·6-63·8)	0·0	2·6	15·7	100	0·2
≤8	1474 (67·5)	93·9 (88·7-97·2)	71·9 (69·9-73·8)	0·1	3·3	19·2	99·8	0·6
≤9	1669 (76·4)	85·7 (79·0-90·9)	80·9 (79·1-82·6)	0·2	4·5	24·4	99·4	1·3
≤10	1848 (84·6)	75·5 (67·7-82·2)	88·9 (87·5-90·2)	0·3	6·8	32·9	98·7	1·9
Rule in:								
≥10	516 (23·6)	85·7 (79-90·9)	80·9 (79·1-82·6)	0·2	4·5	24·4	98·7	24·4
≥11	337 (15·4)	75·5 (67·7-82·2)	88·9 (87·5-90·2)	0·3	6·8	32·9	98·1	32·9
≥12	212 (9·7)	60·5 (52·2-68·5)	94·0 (92·8-95)	0·4	10·0	42·0	97·1	42·0
≥13	100 (4·6)	34·0 (26·4-42·3)	97·5 (96·8-98·2)	0·7	13·9	50·0	95·3	50·0
≥14	37 (1·7)	18·4 (12·5-25·6)	99·5 (99·1-99·8)	0·8	37·4	73·0	94·4	73·0
≥15	17 (0·8)	8·8 (4·8-14·6)	99·8 (99·5-99·9)	0·9	45·1	76·5	93·8	76·5
≥16	4 (0·2)	2·7 (0·7-6·8)	100 (99·8-100)	1·0	-	100·0	93·4	100·0
≥17	1 (0·0)	0·7 (0-3·7)	100 (99·8-100)	1·0	-	100·0	93·3	100·0

LR=Likelihood ratio, FN=false negative, FP=false positive, NPV=negative predictive value, PPV=positive predictive value, TN=true negative, TP=true positive.

Appendix Table 4. Performance of the CCEDRRN COVID Mortality Score to rule out and rule in in-hospital mortality at different cut-off values in the combined derivation and validation cohorts.

Score	n (%)	Sensitivity (%, 95% CI)	Specificity (%, 95% CI)	Negative LR	Positive LR	PPV (%)	NPV (%)	Mortality (%)
Rule out:								
≤-1	178 (1·9)	100·0 (99·4-100·0)	2·0 (1·7-2·3)	0·0	1·0	6·6	100	0·0
≤0	825 (8·6)	100·0 (99·4-100·0)	9·2 (8·6-9·8)	0·0	1·1	7·0	100	0·0
≤1	1499 (15·6)	100·0 (99·4-100·0)	16·7 (15·9-17·5)	0·0	1·2	7·6	100	0·0
≤2	1926 (20·1)	100·0 (99·4-100·0)	21·4 (20·6-22·3)	0·0	1·3	8·0	100	0·0
≤3	2420 (25·2)	100·0 (99·4-100·0)	26·9 (26·0-27·9)	0·0	1·4	8·6	100	0·0
≤4	2910 (30·3)	100·0 (99·4-100·0)	32·4 (31·4-33·4)	0·0	1·5	9·2	100	0·0
≤5	3685 (38·4)	99·8 (99·1-100·0)	41·0 (40·0-42·0)	0·0	1·7	10·4	100	0·0
≤6	4563 (47·5)	99·0 (97·9-99·6)	50·7 (49·7-51·7)	0·0	2·0	12·1	99·9	0·1
≤7	5497 (57·2)	97·4 (95·8-98·5)	61·0 (60·0-62·0)	0·0	2·5	14·7	99·7	0·3
≤8	6410 (66·7)	94·0 (91·8-95·7)	70·9 (70·0-71·9)	0·1	3·2	18·2	99·4	0·6
≤9	7276 (75·8)	88·5 (85·7-90·9)	80·2 (79·3-81·0)	0·1	4·5	23·5	99·0	1·0
≤10	7974 (83·0)	77·7 (74·2-80·9)	87·2 (86·5-87·9)	0·3	6·1	29·4	98·3	1·7
Rule in:								
≥10	2329 (24·2)	88·5 (85·7-90·9)	80·2 (79·3-81·0)	0·1	4·5	23·5	99·0	23·5
≥11	1631 (17·0)	77·7 (74·2-80·9)	87·2 (86·5-87·5)	0·3	6·1	29·4	98·3	29·4
≥12	1083 (11·3)	65·0 (61·1-65·0)	92·4 (91·9-93·0)	0·4	8·6	37·1	97·5	37·1
≥13	604 (6·3)	46·3 (42·3-50·3)	96·5 (96·1-96·8)	0·6	13·1	47·4	96·3	47·4
≥14	276 (2·9)	28·2 (24·6-31·9)	98·9 (98·6-99·1)	0·7	24·8	63·0	95·2	63·0
≥15	100 (1·0)	13·1 (10·5-16·0)	99·8 (99·7-99·9)	0·9	62·0	81·0	94·4	81·0
≥16	29 (0·3)	4·4 (2·9-6·3)	100 (99·9-100)	1·0	196·3	93·1	93·8	93·1
≥17	5 (0·1)	0·8 (0·3-1·9)	100 (100-100)	1·0	-	100·0	93·6	100·0

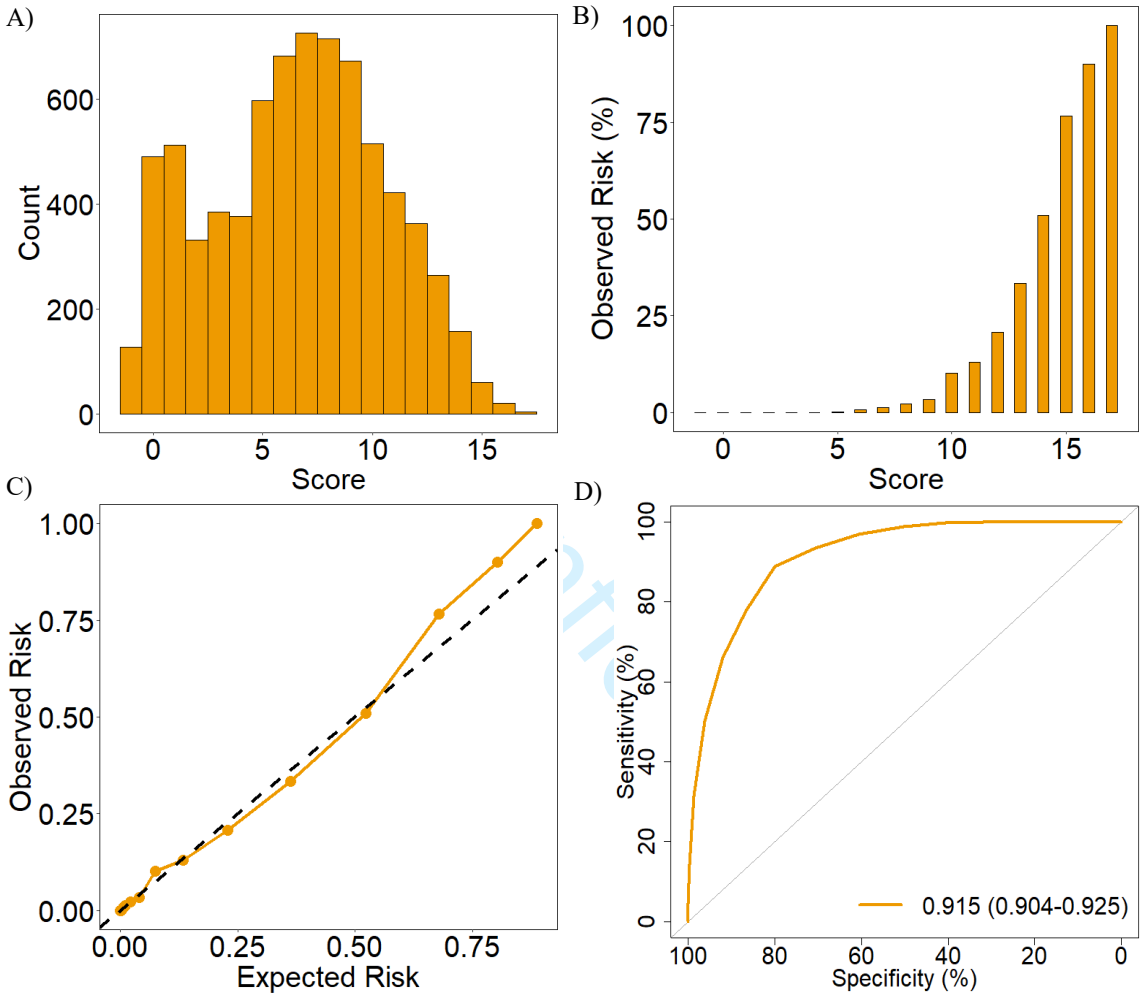
FN=false negative, FP=false positive, NPV=negative predictive value, PPV=positive predictive value, TN=true negative, TP=true positive.

Appendix Table 5. Receiver operator curves and area under the curve (AUC) for the CCEDRRN COVID Mortality Score, the SEIMC score, the 4C Mortality Score, and the VACO Index.

Model	Data set	Patients with required parameters (n)	AUC (95% CI)
CCEDRRN COVID Mortality Score (CCMS)	Derivation and Validation	9605	0·92 (0·91-0·93)
CCEDRRN COVID Mortality Score (CCMS)	Validation	2185	0·92 (0·90-0·93)
SEIMCI score (Berenguer et al.)(11)	Validation	1620	0·88 (0·86-0·91)
4C Mortality Score (Knight et al.)(9)	Validation	610	0·88 (0·84-0·92)
VACO Index (King et al.)(20)	Validation	2185	0·87 (0·84-0· 89)

SEIMC score: the estimated glomerular filtration rate was calculated without race.
4C Mortality Score: human immunodeficiency virus, AIDs, and connective tissue disease, and urea not included.
VACO Index: race, body mass index, acquired immunodeficiency syndrome (AIDS), diabetes with complications, peptic ulcer disease, peripheral vascular disease, and plegia not included.

Appendix Figure 1· Distribution and performance of the CCEDRRN COVID Mortality Score in the derivation cohort: A) distribution of the score, B) observed in-hospital mortality across the range of the score, C) predicted versus observed probability of in-hospital mortality, and D) receiver operating characteristic curve with area under the curve (AUC) and associated 95% confidence interval.



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Canadian COVID-19 ED Network

Supplementary Table: Contributors to the Canadian COVID-19 Emergency Department Rapid Response Network

1. Purpose

This supplementary table provides details of the support staff at each of the participating institutions in the Canadian COVID-19 Emergency Department Rapid Response Network. This supplementary document should be attached to each peer-reviewed manuscript after the methods manuscript (M1). The purpose is to ensure research staffs and lead coordinators are appropriately recognized for their contributions to the network.

2. List of Support Staff

Table 1. Network coordinating centre staff at the University of British Columbia

Name	Roles	Contributions
Gelareh Ghaderi	Data analyst	Data processing and analysis for manuscripts.
Jeffrey Hau	Data manager	REDCap, data processing and analysis for manuscripts.
Vi Ho	National coordinator	Coordinate with provincial coordinators and training/onboarding of research assistants.
Joe Larkin	Project manager	Project management.
Fiona O'Sullivan	Data analyst	Data processing and analysis for manuscripts.
Serena Small	Research coordinator	Ethics & privacy reviews, data management plan, privacy impact assessment, and qualitative analyses
Amber Cragg	Research manager	Data and manuscript management
Wei Zhao	Data analyst	Data processing and analysis for manuscripts.
Vicky Wu	Data analyst	Data processing and analysis for manuscripts.
Elnaz Bodaghkhani	Research associate	Data and manuscript management

Table 2. Provincial Coordinators

Name	Province	Institutional affiliation	Contributions to CCEDRRN
Corinne DeMone	NS	Dalhousie University, Halifax, Nova Scotia	Research ethics board submission, manages research assistants, data cleaning and quality.
Jacqueline Fraser	NB	Dalhousie University, St. John New Brunswick	Site coordinator as well as research assistant.
Veronique Gélinas	QC	Centre intégré de santé et de services sociaux de Chaudière-Appalaches (Hôtel-Dieu de Lévis site), Lévis	Provincial research coordinator, translation of research material to French, ethics management.

Canadian COVID-19 ED Network

Connie Taylor	ON	Queen's University, Kingston	Coordination of research assistants in Ontario, maintenance of REB applications for the province
Kate Mackenzie	MB	Health Sciences Centre, Winnipeg	Lead RA for the province
Aimee Goss	SK	University of Saskatchewan, Saskatoon	Screens records in Saskatoon, data/extraction and entry, coordinates research assistants.
Hina Walia	AB	University of Calgary, Calgary	Provincial coordinator lead for Alberta, oversight of all Alberta sites.
Rajan Bola	BC	University of British Columbia, Vancouver	Provincial coordinator lead for BC, oversight of all BC sites.

Table 3. Institutional research assistant (RA) leads
Institutional RA leads are responsible for data extraction and integrity, communication with provincial leads.

Name	**Province**	**Institutional affiliation(s)**
Corinne DeMone	NS	Dartmouth General Hospital, Cobequid Community Health Centre, Hants Community Hospital Secondary Assessment Centers of the Dartmouth General Hospital, and Halifax Infirmary, Halifax
Jacqueline Fraser	NB	Saint John Regional Hospital, Saint John
Alexandra Nadeau	QC	CHU de Québec Université Laval, Quebec City
Audrey Nolet	QC	Centre intégré de santé et de services sociaux de Chaudière-Appalaches (Hôtel-Dieu de Lévis site), Lévis
Xiaoqing Xue	QC	Jewish General Hospital, Montréal
David Iannuzzi	QC	McGill University Health Center, Montréal
Chantal Lanthier	QC	Hôpital du Sacré-Cœur de Montréal, Montréal
Konika Nirmalanathan	ON	University Health Network, Toronto
Vlad Latiu	ON	Kingston General Hospital, Hotel Dieu Hospital, Kingston
Joanna Yeung	ON	Sunnybrook Health Sciences Center, Toronto
Natasha Clayton	ON	Hamilton General Hospital, Juravinski Hospital, Hamilton
Tom Chen	ON	London Health Sciences Centre, London
Jenna Nichols	ON	Health Sciences North, Sudbury
Kate Mackenzie	MB	Health Sciences Centre, Winnipeg
Aimee Goss	SK	St. Paul's Hospital, Royal University Hospital, Saskatoon City Hospital, Saskatoon
Stacy Ruddell	AB	Foothills Medical Centre, Peter Lougheed Centre, Rockyview General Hospital, South Health Campus, Calgary
Natalie Runham	AB	University of Alberta Hospital, Edmonton

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Name	Province	Institutional affiliation(s)
Karlin Su	AB	Royal Alexandra Hospital/Northeast Community Health Center, Edmonton
Josie Kanu	BC	St. Paul's Hospital, Mount Saint Joseph, Vancouver
Bernice Huynh	BC	Abbotsford Regional Hospital and Cancer Center, Abbotsford
Amanda Swirhun	BC	Royal Columbian Hospital, New Westminster
Tracy Taylor	BC	Eagle Ridge Hospital and Health Care Centre, Port Moody
Mai Hayashi	BC	Royal Inland Hospital, Kamloops
Mackenzie Cheyne	BC	Kelowna General Hospital, Kelowna
Sarim Asim	BC	Surrey Memorial Hospital, Surrey
Katherine Lam	BC	Vancouver General Hospital, Vancouver
Kelsey Compagna	BC	Lions Gate Hospital, Vancouver

Table 4. Contributing Study Sites and Investigators

Lead Investigator	Contributing Site / Code	Member Investigators
Maritime		
Patrick Fok		
Nova Scotia		
Hana Wiemer	Halifax Infirmary/ 902	Patrick Fok
	Dartmouth General Hospital/ 903	Hana Wiemer
	Hants Community Hospital/ 904	Samuel Campbell
	Cobequid Community Health Centre/ 905	Kory Arsenault
	Secondary Assessment Centers of Dartmouth General and Halifax Infirmary/ 908	Tara Dahn
New Brunswick		
Kavish Chandra	Saint John Regional Hospital/ 901	Kavish Chandra
Quebec		
Patrick Archambault	Hotel-Dieu de Lévis/ 701	Patrick Archambault
	Jewish General Hospital/ 702	Joel Turner
	Centre Hospitalier de l'Université Laval (CHU de Québec)/ 703	Éric Mercier
	L'hôpital Royal Victoria - Royal Victoria Hospital/ 705	Greg Clark
	Hôpital de l'Enfant-Jésus,CHU de Québec/ 706	Éric Mercier
	Hôpital du Saint-Sacrement, CHU de Québec/ 707	Éric Mercier
	Hôpital Saint-François d'Assise, CHU de Québec/ 708	Éric Mercier
	Hôtel-Dieu de Québec,CHU de Québec/ 709	Éric Mercier

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	IUCPQ: Institut universitaire de cardiologie et de pneumologie de Québec/ 710	Sébastien Robert
	Hôpital du Sacré-Coeur de Montreal/ 711	Raoul Daoust
Ontario		
Laurie Morrison & Steven Brooks	Sunnybrook/ 401	Ivy Cheng
	The Ottawa Hospital - Civic Campus/ 403	Krishan Yadav
	The Ottawa Hospital - General Campus/ 404	Krishan Yadav
	Kingston/Queens/ 406	Steven Brooks
	Hamilton General Hospital/ 407	Michelle Welsford
	Health Science North, Sudbury Ontario/ 408	Rob Ohle
	University Hospital – LHSC/ 409	Justin Yan
	North York General Hospital, Toronto/ 410	Rohit Mohindra
	Victoria Hospital – LHSC/ 412	Justin Yan
	Toronto Western Hospital/ 414	Megan Landes
Manitoba		
Tomislav Jelic	Health Sciences Centre/ 307	Tomislav Jelic
Saskatchewan		
Phil Davis	Pasqua Hospital, Regina/ 301	Ankit Kapur
	Regina General Hospital, Regina/ 302	Ankit Kapur
	St Paul's Hospital, Saskatoon/ 303	Phil Davis
	Royal University, Saskatoon/ 304	Phil Davis
	Saskatoon City Hospital, Saskatoon/ 305	Phil Davis
Alberta		
Andrew McRae	University of Alberta Hospital, Edmonton/ 201	Brian Rowe
	Foothills, Calgary/ 202	Katie Lin
	Rockyview, Calgary/ 203	Andrew McRae
	Peter Lougheed Centre/ 204	Andrew McRae
	South Campus, Calgary/ 205	Stephanie VandenBerg
	Northeast Community Health Centre, Edmonton/ 206	Jake Hayward, Jaspreet Khangura
	Royal Alexandra Hospital, Edmonton/ 306	Jake Hayward, Jaspreet Khangura
British Columbia		
Corinne Hohl	Vancouver General Hospital/ 101	Daniel Ting
	Lions Gate Hospital/ 102	Maja Stachura
	Saint Paul's Hospital/ 103	Frank Scheuermeyer

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Mount St Joseph's/ 104	Frank Scheuermeyer
Surrey Memorial Hospital/ 105	Balijeet Braar/ Craig Murray
Royal Columbian Hospital/ 106	John Taylor
Abbotsford Regional Hospital/ 107	Ian Martin
Eagle Ridge Hospital/ 108	Sean Wormsbecker
Victoria General Hospital/ 109	Matt Bouchard
Royal Jubilee Hospital/ 110	Matt Bouchard
Nanaimo General Hospital/ 111	Matt Bouchard
Royal Inland Hospital/ 112	Ian Martin
Kelowna General / Hospital/ 115	Lee Graham

It was not possible for us to recruit Members from Newfoundland and Labrador, Northwest Territories, Nunavut, Prince Edward Island and Yukon at the time of the inception of the registry.